

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Patent Application of	)	<b>MAIL STOP</b>
Brooks, Paul Joseph et al.	)	<b>APPEAL BRIEF PATENTS</b>
Application No.: 10/584,407	)	Group Art Unit: 1783
Filed: June 26, 2006	)	Examiner: Khatri, Prashant J.
For: Thermal Control Film for Spacecraft	)	Confirmation No.: 9864

**APPEAL BRIEF**

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

This appeal is from the decision of the Primary Examiner dated June 10, 2011 finally rejecting claims 1, 4, 6-10, 14-18, 21, 23, and 24, which are reproduced as the Claims Appendix of this brief.

☒ Charge ☐ \$ 310.00 (2402) ☒ \$ 620.00 (1402) to Credit Card. Fee being paid concurrent with the filing of this Appeal Brief.

The Commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§1.16, 1.17, and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800.

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**I. Real Party in Interest**

Astrium Limited of Stevenage, Hertfordshire, United Kingdom is the real party in interest, and is the assignee of Application No. 10/584,407.

**II. Related Appeals and Interferences**

The Appellant's legal representative, or assignee, does not know of any other appeal or interferences that will affect or be directly affected by or have bearing on the Board's decision in the pending appeal.

**III. Status of Claims**

- A. There are 13 total claims currently pending in the application.
- B. Current status of the claims
  - 1. Claims canceled: 2, 3, 5, 11-13, 19, 20, and 22
  - 2. Claims withdrawn from consideration but not canceled: None
  - 3. Claims pending: 1, 4, 6-10, 14-18, 21, 23, and 24 and
  - 4. Claims allowed: None
  - 5. Claims rejected: 1, 4, 6-10, 14-18, 21, 23, and 24
  - 6. Claims on appeal: 1, 4, 6-10, 14-18, 21, 23, and 24

**IV. Status of Amendments**

No Amendments were filed subsequent to the final Office Action dated June 10, 2011.

**V. Summary Claimed Subject Matter**

As shown in Figs. 1-5, an exemplary antenna has an active face on which a thermal control film is disposed (pg. 10, lines 8-12). The thermal control film has a polymeric multi-layer structure that includes a set of interference filters (pg. 8, lines 21-24). The layer structure of the thermal control film includes a stack of alternating

high and low refractive index dielectric films (pg. 5, lines 19-21). The thermal control film has a low absorbency of solar radiation, and a high absorbency and emissive characteristic in the infrared wavelength range 2.5 $\mu$ m to 50 $\mu$ m, which corresponds to the spectrum of heat generated by the high frequency circuits of the antenna array (pg. 8, lines 24-32). The film also exhibits a high transparency to the microwave frequencies, typically 1 to 30 GHz (pg. 8, lines 30-32).

The table that follows maps Appellant's independent claims to those portions of the disclosure that support the recited feature.

Claim #	Claim element	Support
1	<p>An antenna comprising:  an active face, at least one radiating element for transmitting radio frequency (RF) signals via the active face, and a metal free thermal control film covering the active face, the metal free thermal control film comprising:  a multi-layer interference filter having alternating higher and lower refractive index layers arranged to filter optical radiation based on interference effects between different components of the optical radiation produced by reflection at boundaries between the layers, said control film exhibiting preselected high absorbency and emissive characteristics in an infrared wavelength range between 2.5<math>\mu</math>m to 50<math>\mu</math>m and low absorbency characteristics in a solar spectrum range between 200nm to 2500nm to limit solar input and allow heat dissipated in the antenna to be radiated into space via the active face, the control film further exhibiting high transmissive characteristics in a microwave frequency spectrum 1 to 30GHz to allow the RF signals to be transmitted via the active face.</p>	<p>pg. 10, lines 8-12</p> <p>pg. 5, lines 19-21; pg. 8, lines 21-32</p>

Claim #	Claim element	Support
23	<p>A spacecraft antenna comprising  an active face comprising at least one  radiating element for transmitting radio  frequency (RF) signals, and  a metal free thermal control film covering  the active face, the metal free thermal control  film comprising a multi-layer interference  filter having alternating higher and lower  refractive index layers arranged to filter  optical radiation based on interference  effects between different components of the  optical radiation produced by reflection at  boundaries between the layers, said control  film exhibiting sufficiently high absorbency  and emissive characteristics in an infrared  wavelength range 2.5 <math>\mu\text{m}</math> to 50 <math>\mu\text{m}</math> and  sufficiently low absorbency characteristics in  a solar spectrum range 200nm to 2500nm to  limit solar input and allow heat dissipated in  the antenna to be radiated into space via the  active face, the control film further exhibiting  sufficiently high transmissive characteristics  in a microwave frequency spectrum 1 to 30  GHz to allow through RF signals transmitted  by said at least one radiating element.</p>	<p>pg. 10, lines 8-12</p> <p>pg. 5, lines 19-21;  pg. 8, lines 21-32</p>

Claim #	Claim element	Support
24	A spacecraft antenna comprising an active face comprising at least one radiating element for transmitting radio frequency (RF) signals, and a metal free thermal control film covering the active face, the metal free thermal control film comprising a multi-layer interference filter having alternating higher and lower refractive index layers arranged to filter optical radiation based on interference effects between different components of the optical radiation produced by reflection at boundaries between the layers, said control film being configured to absorb and emit radiation in an infrared wavelength range 2.5 μm to 50 μm to dissipate waste heat produced by active components of the antenna into space via the active face, said control film being configured to reflect solar radiation to limit solar input via the active face, and, the control film further being configured to transmit radiation in a microwave frequency spectrum 1 to 30 GHz to allow through RF signals transmitted by said at least one radiating element.	pg. 10, lines 8-12  pg. 5, lines 19-21; pg. 8, lines 21-32

## VI. Grounds of Rejection to be Reviewed on Appeal

Whether:

1. Claims 1, 4, 6-10, 14-18, 21, and 23 are indefinite under 35 U.S.C. §112, second paragraph;
2. Claims 1, 4, 6, 9-10, 14, 21, 23, and 24 are unpatentable over *Rogers et al* (U.S. Patent No. 4,479,131) in view of *Jonza et al.* (U.S. Patent No. 5,882,774) with evidence from *3M<sup>TM</sup> Radiant Mirror Film VM2000F1A6 Product Sheet* ("3M Product Sheet") under 35 U.S.C. §103(a); and

3. Claims 7, 8, and 15-18 are unpatentable over *Rogers* in view of *Jonza* with evidence from the 3M Product Sheet, and further in view of *Iacovangelo et al.* (US 6,587,263).

## VII. Argument

### 1. The terms "High" and "Low"

U.S. Patent No. 6,587,263 ("the '263 patent"), which is discussed in the Background section of Appellant's disclosure, describes an optical solar reflector (OSR) that includes, among other features, a radiative layer 108. The radiative layer 108 is described as being chosen to have "low absorbency or electromagnetic radiation", which "avoids heating the spacecraft due to absorption of this energy" (Emphasis added, col. 4, lines 3-19). The radiative layer 108 also has high absorbency and emissivity in an infrared wavelength range. Absorbency ( $\alpha$ ) values in an electromagnetic range of 200 nm to 2500 nm and emissivity (E) values in an infrared range of 2.5  $\mu\text{m}$  to 25  $\mu\text{m}$  were determined through tests (See Table A).

**TABLE A**

<u>Alpha and emissivity values of PECVD coating on Ag</u>				
Coating	Thick ( $\mu\text{m}$ )	$\alpha$	E	$\alpha/E$
SiO <sub>2</sub>	12.8	0.184	0.811	0.226
SiO <sub>1.14</sub> N <sub>0.57</sub>	16.7	0.073	0.854	0.085
SiO <sub>0.8</sub> N <sub>0.8</sub>	16.8	0.070	0.857	0.082
SiO <sub>0.5</sub> N	16.5	0.068	—	—
SiO <sub>3</sub> N <sub>4</sub>	13.6	0.083	0.847	0.098
standard	50	0.075	0.846	0.088

In the final rejection, the Examiner argues that the values for emissivity and absorbency are not applicable to the thermal film recited Appellant's claims because the film described in the '263 patent is of a different material. While Appellant acknowledges that the material disclosed in the '263 patent and the thermal material recited in Appellant's claims are different, this difference is irrelevant to the evidence that the '263 patent provides regarding an exemplary range of values. One of ordinary skill would have understood the manner of quantify "high absorbency", "high emissivity", and "low absorbency" as recited in the claims.

Emissivity ( $\epsilon$ ) is the ratio of the radiation emitted by a Blackbody at certain temperature and the radiation emitted by the object under analysis at the same temperature (See Exhibit A: "Emissivity: The Common Problem for all Thermographers", InfraMation, vol. 3, issue 4, pg. 1, April 2002). Good radiators have an emissivity closer to 1, whereas poor radiators have an emissivity closer to 0. Thus, the determination of emissivity for a material is well within the knowledge of one of skill in the art where high emissivity would be regarded as those values closer to 1 and low emissivity as those values closer to 0.

At the time of filing, one of ordinary skill in the art would have known that absorbency is the fraction of light absorbed by a sample (See Exhibit B: "Principles of Spectrophotometry", <<http://www.ruf.rice.edu/~bioslabs/methods/protein/spectrophotometer.html>>, David R. Caprette, Rice University September 16, 1996, Updated May 19, 2005). If light is directed on one face of a material and no light is detected on an opposite face then the absorbency of the material would be 100%. On the other hand, if the intensity of light detected at the opposite face is the same is the intensity emitted at the light



source then the absorbency of the material is 0%. Thus, for any given material and particularly for the thermal material recited in Appellant's claims, it would have been well within the purview of one of skill in the art to establish the absorbency of the thermal material such that those values closer to 100% would represent high absorbency and those values closer to 0% would represent low absorbency.

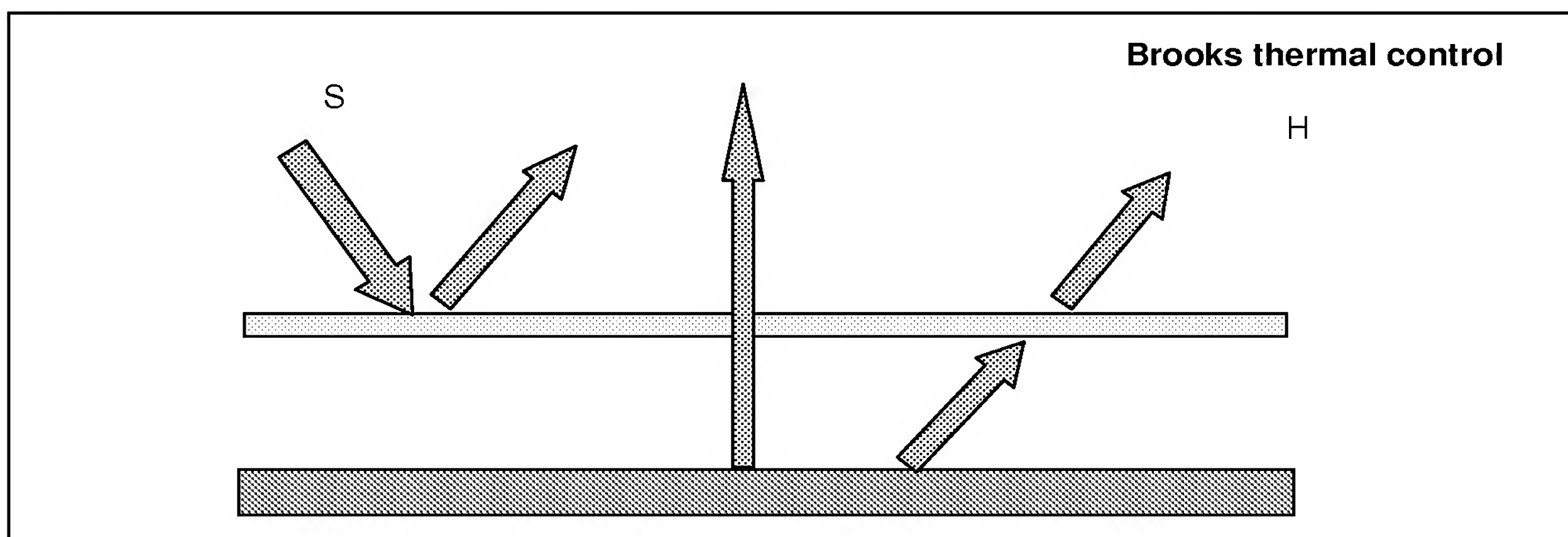
Given the knowledge of one of skill in the art at the time of filing, it should be understood that the values in TABLE A of the '236 patent are not relied upon to show the exact values that the thermal material embodied in the claims would exhibit. Rather, because the scale for determining at least emissivity would have been known to one of skill in the art, and is standardized for all materials this same person of skill would have been able to ascertain a corresponding high or low value of emissivity as claimed and provided in the context of Appellant's disclosure. In other words, despite the type of material used, because the scale used to measure emissivity and absorbency is standardized it follows that the determination of whether a material has high or low emissivity or absorbency is not based upon a reference value for the respective material but rather upon the values of a respective material with regard to the standardized scale. Additionally, the absorbency of the Appellant's claimed thermal material could have been established through routine measures.

For these reasons, Appellant believes that the terms "high" and "low" as recited in Appellant's claims are clear, precise, and otherwise definite.

2. **The combination of *Rogers* and *Jonza* does not disclose or suggest "a control film exhibiting preselected high absorbency and emissive characteristics in an infrared wavelength range between 2.5 $\mu$ m to 50 $\mu$ m and low absorbency characteristics in a solar spectrum range between 200nm to 2500nm to limit solar input and allow heat dissipated in the antenna to be radiated into space via the active face"**

Appellant maintains that the prior art combination, and particularly, *Rogers* fails to disclose or suggest an antenna having an active face, and a thermal film being provided on the active face, as recited in Appellant's claim 1.

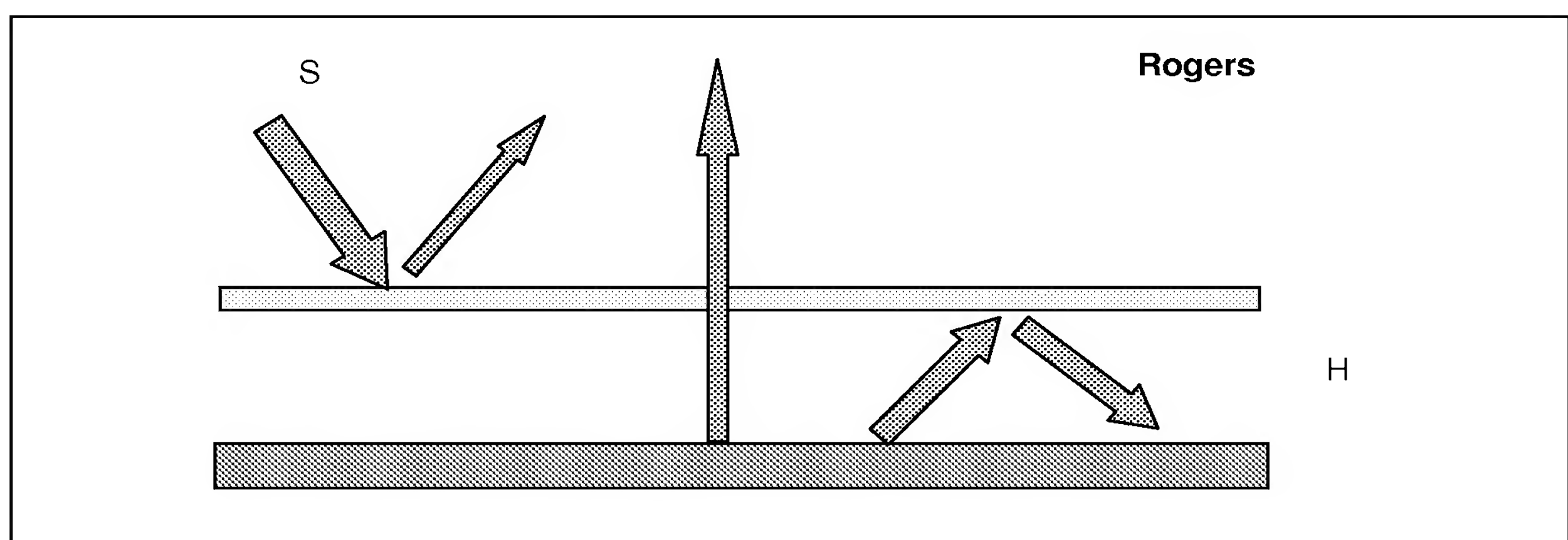
The embodiments as recited in Appellant's independent claims are directed to an active antenna system that generates and transmits the spacecraft RF signal (see inset e.g., Brooks thermal control). An "active" antenna system is one that consumes electrical power to create, process, and transmit the RF signal.



An active antenna generates a significant amount of waste heat as part of the generation of the RF signal and must be efficiently radiated away from the antenna into space without overheating the active antenna. Through the combination of features recited therein, the claimed embodiments reflect away sunlight, to allow transmission of the RF signal and the transmission of heat generated in the antenna.

Interference filter technology is used to produce a reflectivity of at least 80%, which leads to a lower absorbed solar heat load and therefore a greater ability to deal with the heat generated in the active antenna.

*Rogers* discloses a thermal shield positioned in front of an antenna reflector. The shield comprises a semiconductor optical coating and a capacitive grid on a substrate. The shield is provided on a passive reflector to focus signals onto a receiver (col. 2, lines 6-11; Fig. 1). The optical coating is designed such that not all solar energy will be absorbed by the coating on the sun side of the shield and to prevent heating of the shield. The optical coating also provides for the shield radiating heat, resulting from the absorbed solar energy, back into space (col. 2, lines 60-68). The combination of a capacitive aluminum grid and the optical coating/film provide the desired emissive characteristics, as the optical coating is



provided to reduce solar transmittance and the capacitive grid stops the solar radiation (col. 4, lines 18 to 23; see "Rogers" inset).

One of skill in the art would have understood that Rogers discloses the use of an RF transparent thermal blanket for an antenna reflector that passively reflects RF energy generated elsewhere in the spacecraft. This thermal blanket impedes heat flow and therefore does not allow the waste heat to be dumped to space without a

large rise in temperature. As a result, the temperature of the antenna would be too high and the system would be unviable. In the final Office Action, the Examiner alleges that the arrangement of *Rogers* comprises an active face that is disposed on the side of the antenna disposed in front of the RF transmitter (See Office Action, June 10, 2011, pg. 10). However, because a reflective antenna cannot create, process, and transmit an RF signal none of the faces of the antenna can reasonably be deemed an active face. *Rogers* does not disclose any face of the described reflecting antenna that comprises at least one radiating element as recited in Appellant's claims.

Moreover, the coating described in *Rogers* is only disclosed with reference to having high thermal emittance in the infrared radiation range corresponding to absorbed solar energy. *Rogers* fails to provide any guidance concerning how the coating would handle infrared radiation, incident from the reflector side, in the IR spectrum range (2.5um to 25um). This energy range corresponds to excess heat generated by the electronic devices within the antenna itself. Based on the configuration of the coating and the lack of discussion in *Rogers*, it appears that IR energy resulting from the electronic devices would be trapped by the shield. Consequently, the coating of *Rogers* does not appear to be suitable for an active face that comprises radiating elements as is embodied in Appellants' claims.

*Jonza* discloses an optical film having a multilayered polymeric sheet with alternating layers of polyethylene naphthalate and a polymer that is a reflective polarizer or mirror. The multilayer construction as shown in Fig. 1b includes alternate low and high index thick films having no tuned wavelengths or bandwidth constraints. The preferred multilayer stack ensures that wavelengths that would be

most strongly absorbed by the stack are the first wavelengths that would be most strongly absorbed by the stack.

However, neither *Jonza* nor the *3M Product Sheet* provides motivation to modify a film such that it can be provided on an active face in order to let RF signals out, along with the waste heat, while also minimizing the heat generated by incident radiation from the sun. Stated differently, the combination of *Rogers*, *Jonza*, and the 3M Product Sheet fails to disclose or suggest "said control film exhibiting preselected high absorbency and emissive characteristics in an infrared wavelength range between 2.5 $\mu$ m to 50 $\mu$ m and low absorbency characteristics in a solar spectrum range between 200nm to 2500nm to limit solar input and allow heat dissipated in the antenna to be radiated into space via the active face", as recited in independent claims 1, 23, and 24. Moreover, these documents would not have guided one of skill in the art with regard to modifying the shield of *Rogers* into a film that can be used on an active face. The skilled artisan would not have looked to modify the shield of *Rogers* to emit IR radiation as recited in Appellant's claims because the shield is provided on a passive reflector and would not be required to emit heat generated by active components within the antenna.

In summary, *Rogers*, *Jonza*, and the *3M Product Sheet* when applied individually or collectively fail to disclose or suggest every feature and/or the combination of features recited in Appellant's claims. For these reasons and those discussed in detail above, a *prima facie* case of obviousness has not been established. Withdrawal of the rejection to independent claims 1, 23, and 24 and dependent claims 4, 6, 9-10, 14, and 21 is respectfully requested.

3. ***lacovangelo* does not remedy the deficiencies of *Rogers* and *Jonza***

Claims 7, 8, and 15-18 variously depend from claim 1. By virtue of this dependency, these claims are distinguishable over the applied combination of references because *lacovangelo* fails to remedy the deficiencies of *Rogers*, *Jonza*, and *the 3M Product Sheet* identified above. Moreover, the subject claims are deemed to be further distinguishable over the applied references due to the respective additional features recited therein. Withdrawal of this rejection, therefore, is respectfully requested.

**VIII. Claims Appendix**

See attached Claims Appendix for a copy of the claims involved in the appeal.

**IX. Evidence Appendix**

Evidentiary Exhibits A and B are provided with this Appeal.

**X. Related Proceedings Appendix**

No related proceedings are associated with this Appeal.

## **XI. Conclusion**

Appellant has pointed to errors in the rejection of the claims. Appellant respectfully requests that the final rejection be reversed and the application be returned to the Examiner for prompt allowance.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date December 7, 2011

By: /Shawn B. Cage/  
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703 836 6620

## VIII. CLAIMS APPENDIX

### The Appealed Claims

1. An antenna comprising:  
an active face, at least one radiating element for transmitting radio frequency (RF) signals via the active face, and a metal free thermal control film covering the active face, the metal free thermal control film comprising:  
a multi-layer interference filter having alternating higher and lower refractive index layers arranged to filter optical radiation based on interference effects between different components of the optical radiation produced by reflection at boundaries between the layers, said control film exhibiting preselected high absorbency and emissive characteristics in an infrared wavelength range between 2.5 $\mu$ m to 50 $\mu$ m and low absorbency characteristics in a solar spectrum range between 200nm to 2500nm to limit solar input and allow heat dissipated in the antenna to be radiated into space via the active face, the control film further exhibiting high transmissive characteristics in a microwave frequency spectrum 1 to 30GHz to allow the RF signals to be transmitted via the active face.
4. The antenna according to claim 1, wherein the film is in the form of a flexible sheet.
6. The antenna according to claim 1 wherein the multi-layer interference filter is a polymeric structure.
7. The antenna according to claim 1, wherein the multi-layer interference filter comprises one or more layers of any of combination of SiO<sub>2</sub>, SiO<sub>x</sub>N<sub>y</sub>, and Si<sub>3</sub>N<sub>4</sub>.
8. The antenna according to claim 7, wherein the film is in the form of a plurality of tiles.
9. The antenna according to claim 1, wherein a thickness of the film is less than 200 microns.



10. The antenna according to claim 1, wherein a thickness of the film is in the range of 50 to 150 microns.

14. The antenna according to claim 4 wherein the multi-layer interference filter is a polymeric structure.

15. The antenna according to claim 14, wherein the multi-layer interference filter comprises one or more layers of any of combination of  $\text{SiO}_2$ ,  $\text{SiO}_x\text{N}_y$ , and  $\text{Si}_3\text{N}_4$ .

16. The antenna according to claim 15, wherein the film is in the form of a plurality of tiles.

17. The antenna according to claim 16, wherein the thickness of the film is less than 200 microns.

18. The antenna according to claim 17, wherein the thickness of the film is in a range of 50 to 150 microns.

21. The antenna according to claim 1 wherein the film is formed by applying a liquid coating to a surface of a spacecraft.

23. A spacecraft antenna comprising  
an active face comprising at least one radiating element for transmitting radio frequency (RF) signals, and

a metal free thermal control film covering the active face, the metal free thermal control film comprising a multi-layer interference filter having alternating higher and lower refractive index layers arranged to filter optical radiation based on interference effects between different components of the optical radiation produced by reflection at boundaries between the layers, said control film exhibiting sufficiently high absorbency and emissive characteristics in an infrared wavelength range 2.5  $\mu\text{m}$  to 50  $\mu\text{m}$  and sufficiently low absorbency characteristics in a solar spectrum range 200nm to 2500nm to limit solar input and allow heat dissipated in the antenna to be radiated into space via the active face, the control film further exhibiting

sufficiently high transmissive characteristics in a microwave frequency spectrum 1 to 30 GHz to allow through RF signals transmitted by said at least one radiating element.

24. A spacecraft antenna comprising  
an active face comprising at least one radiating element for transmitting radio frequency (RF) signals, and

a metal free thermal control film covering the active face, the metal free thermal control film comprising a multi-layer interference filter having alternating higher and lower refractive index layers arranged to filter optical radiation based on interference effects between different components of the optical radiation produced by reflection at boundaries between the layers, said control film being configured to absorb and emit radiation in an infrared wavelength range 2.5  $\mu\text{m}$  to 50  $\mu\text{m}$  to dissipate waste heat produced by active components of the antenna into space via the active face, said control film being configured to reflect solar radiation to limit solar input via the active face, and, the control film further being configured to transmit radiation in a microwave frequency spectrum 1 to 30 GHz to allow through RF signals transmitted by said at least one radiating element.

## **IX. EVIDENCE APPENDIX**

# Exhibit A

## Exhibit B

## **X. RELATED PROCEEDINGS APPENDIX**

NONE